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**CENTRAL FILES NUMBER**
63-12-39

COPY NO. 10

DATE: December 23, 1963

SUBJECT: APPLIED HEALTH PHYSICS QUARTERLY REPORT - JULY, AUGUST, AND SEPTEMBER OF 1963

TO: K. Z. Morgan - W. S. Snyder

FROM: D. M. Davis







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HEALTH PHYSICS DIVISION

# APPLIED HEALTH PHYSICS QUARTERLY REPORT - JULY, AUGUST, AND SEPTEMBER OF 1963


D. M. Davis, Section Chief

Data Contributed By:

H. H. Abee
R. L. Clark
E. D. Gupton
A. D. Warden

J. C. Hart, Editor

## TABLE OF CONTENTS

# 1.0 MONITORING SUMMARY

## 1.1 Unusual Occurrences

The Laboratory experienced ten unusual occurrences during the third quarter of 1963. Eight of the occurrences were classified as minor occurrences and two were classified as radiation events. The two radiation events involved reclamation costs that exceeded the sum of $500. There were no significant personnel exposures involved.

## 1.2 Personnel Exposures

No employee exceeded a recommended maximum quarterly dose. The highest exposure recorded was 60 per cent of the appropriate recommended maximum quarterly dose.

## 1.3 Atmospheric Monitoring

The radioactive concentration in air continued a downward trend from a peak value reached during the month of April of this year. The average concentrations at both the PAM (AEC controlled area) and RAM (stations located 12 to 75 miles from ORNL) networks dropped to approximately 1/2 of the average concentration recorded for the previous quarter (April, May, June, 1963). As the averages for the PAM network and RAM network were essentially the same, and the quarterly averages of the various stations within the PAM network did not vary appreciably (less than 20 per cent), it is evident that ORNL operations did not contribute significantly to air-borne radioactivity in the East Tennessee area during the third quarter of 1963.

## 1.4 Water Monitoring

The average concentration of radioactive materials in Clinch River water sampled at the ORGDP filtration plant intake continued to decrease averaging 4.4 per cent of the $(MPC)_w$ for persons residing in the neighborhood of an atomic energy installation; the average recorded during the second quarter was 6 per cent of the $(MPC)_w$; the average for 1962 was 11.2 per cent of the $(MPC)_w$. This continuing decrease may be attributed to a decrease in the amount of radioactivity discharged to the Clinch River. During the first nine months of this year a total of 422 curies of radioactive materials was discharged from White Oak Lake to the Clinch River. This compares to 1124 curies discharged during the corresponding period of 1962.

## 1.5 Background Measurements of Ionizing Radiation

The average background level recorded during the third quarter at 53 stations located on or near the X-10 site was 0.11 mR/hr. The off-site average was 0.033 mR/hr. The third quarter values differ only slightly from those recorded during the previous quarter.

# 2.0 RADIATION SURVEY SECTION

## 2.1 Summary of Unusual Occurrences

The Laboratory experienced ten unusual occurrences[1] during the third quarter. Eight of the occurrences were classified as minor occurrences and two were classified as radiation events. Three occurrences (Table 2.1, Items 1, 5 and 10) were attributed to faulty or inadequate equipment; four occurrences (table 2.1, Items 2, 3, 4 and 8) were attributed to the failure to use adequate care in some part of the operation; two occurrences (Table 2.1, Items 6 and 7) were due to the failure of employees to follow operating procedures. One occurrence involved a radiation exposure to a film meter allegedly used by an employee (Table 2.1, Item 9) and required the appointment of an AEC investigating committee. The committee concluded that no personnel exposure occurred.

Six of the unusual occurrences involved area and/or equipment contamination. The decontamination effort in four of these occurrences was handled internally by the regular work staff with no appreciable departmental program loss. Two occurrences required special handling prior to the resumption of normal operations and were classified as radiation events since the cost of reclamation exceeded the sum of $500. On six occasions minor personnel contamination was involved.

Unusual occurrences took place in seven operating facilities. Two incidents occurred in each of three facilities; four other facilities experienced one unusual occurrence each (Table 2.1). Six of the ten unusual occurrences were experienced within facilities concerned primarily with chemical type operations. The remaining four incidents occurred in facilities where mechanical or service type operations were being performed.

A comparison of the number of occurrences for the years 1960, 1961, 1962 and the first three quarters of 1963 is presented in Fig. 2.1.

## 2.2 Radiation Events

The Applied Health Physics Quarterly Report for January, February and March 1963 (paragraph 2.1, B, page 6, Item 3) classifies an unusual occurrence as a "radiation event" when "recovery and/or evaluation costs equal or exceed" the sum of $500. Two such events occurred during the third quarter as follows:

1. Above normal air-borne radioactivity was noted in Bldg. 3042 (ORR) on July 1, 1963, when a fuel element was found to have ruptured.

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[1] See the Applied Health Physics Quarterly Report for January, February and March, 1963, for definition of the term "unusual occurrence". This report also describes a method for classifying radiation accidents, or near accidents, according to a severity index system.

Table 2.1 Radiation Occurrences Tabulated for 3rd Quarter, 1963

| No. | Date | Facility(s) Involved | Division(s) Involved | Subject of Unusual Occurrence Report |
|---|---|---|---|---|
| 1. | 7-1-63 | Bldg. 3042 (ORR) | Operations | Release of Air-Borne Radioactive Materials Resulting from a Leaking Fuel Element in the Reactor Core. |
| 2. | 7-11-63 | Bldg. 3047 (Rm. 207) | Isotopes | Local and Off-Site Surface Contamination Involving Pm-147. |
| 3. | 7-11-63 | Bldg. 3019 (Rm. 303) | Chem. Tech. | Radioactive Contamination Resulting from Connection of Instrument Line to a Carrier in Cell # 3. |
| 4. | 7-24-63 | Pit Area S. of Bldg. 4507 | Chem. Tech. | Spillage of Waste Fission Products Materials During Removal of Filter Tank from Pit. |
| 5. | 8-5-63 | Bldg. 3019 (HRLAF Cell # 2) | Anal. Chem. | Spread of Cm-242 During Removal of Containment Box from HRLAF Cell # 2 to the Burial Ground. |
| 6. | 8-6-63 | Bldg. 3019 (VPP-Cell 2) | Chem. Tech. | Personnel and Surface Contamination Resulting from Failure to Follow the Operational Procedure. |
| 7. | 8-6-63 | Bldg. 3019 (HRLAF) | Anal. Chem. | Personnel Contamination Detected Outside Contamination Zone as the Result of Failure to Follow the Area Operating Procedure. |
| 8. | 8-13-63 | Bldg. 3042 (ORR) | Operations | Release of Radioactive Gaseous Material During Manipulation of Valves Associated with the Demineralizer Equipment in the Reactor Water System. |
| 9. | 8-5-63 | Bldg. 9207 (4th floor) | Biology | Investigation of Film Meter Reading. |
| 10. | 9-15-63 | Tank Farm (South) | Operations | Personnel Contamination Resulting from Sampling Operation at W-8 Pump. |

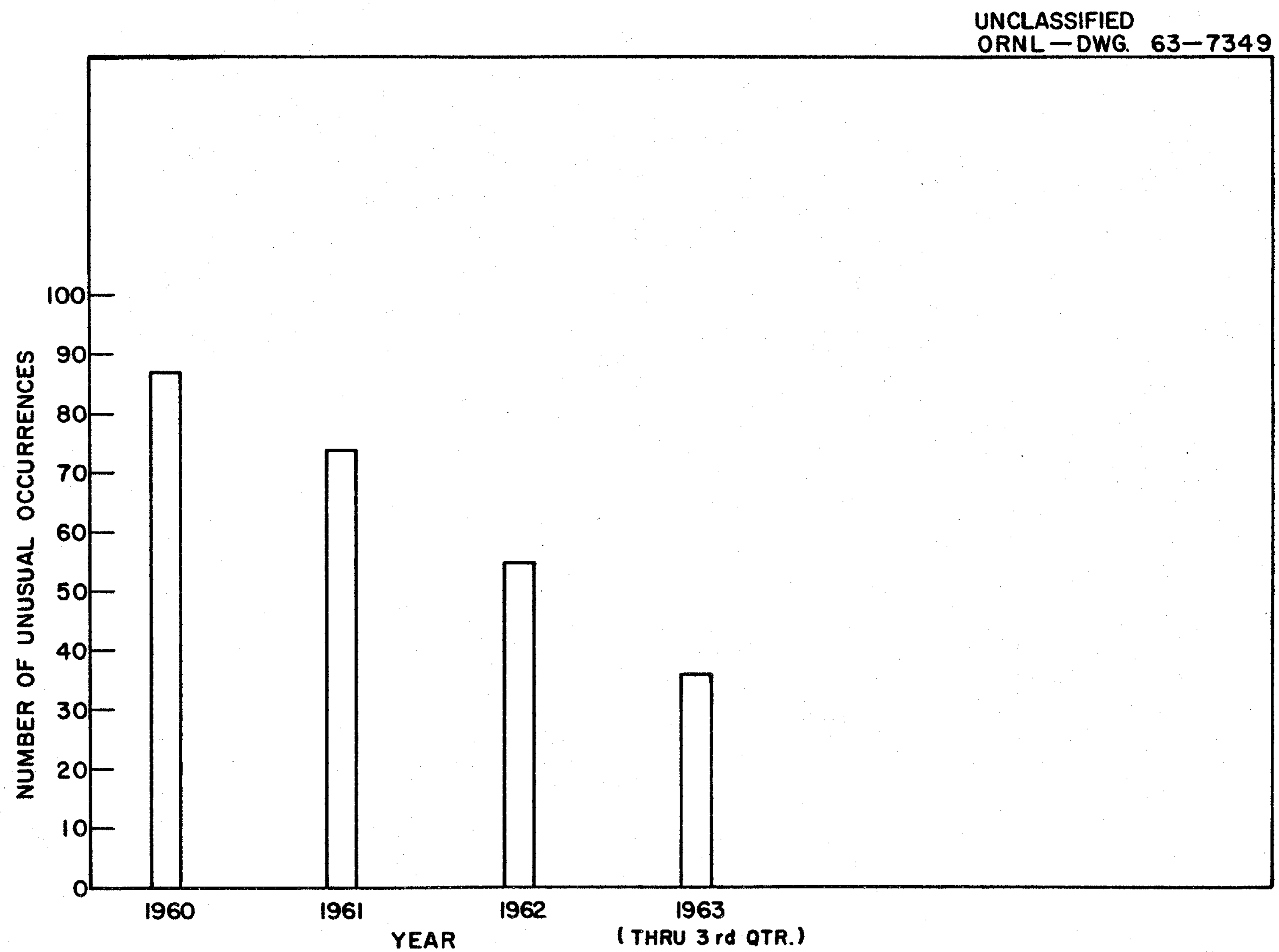


Fig. 2.1 Number Of Unusual Occurrences By Year, 1960—1963

The reactor was shut down and personnel evacuated from the building. Air-borne radioactive contaminants, consisting primarily of Rb-88 and Cs-137, were found to have been released into the building. There was no significant contamination of personnel. However, operations were curtailed for a period of several hours while the defective fuel element was being replaced.

2. An employee, engaged in an electroplating operation which utilized a quantity of Pm-147, unknowingly contaminated his hands and clothing during a last minute examination of the apparatus just prior to his leaving the Laboratory at the end of the work shift. The Pm-147 contaminant was carried on the person of the employee to a private automobile used in commuting to work, the home of the employee, and was later found on balls and bats which the employee had handled that evening as a participant in a Laboratory-sponsored softball game. All persons who had occasion to come in contact with the contaminant were thoroughly checked for contamination. The employee and one other individual were found to have sustained a small fraction of a Pm-147 body burden as determined by urinalysis techniques.

The incident resulted from the failure of the employee to observe operating procedures and presented a situation which pointed up the necessity of rigid compliance with established procedures. The employee had completed his day's assignment which normally called for clean-up measures prior to leaving the job. In this instance, after having left the work area following the day's assignment, the employee returned for a last-minute inspection of the apparatus and then left the work area for home without performing the standard contamination survey.

The extensive spread of contamination and the number of people involved resulted in clean-up measures and evaluation costs that exceeded the sum of $500. The cost factor required that the occurrence be classified as a radiation event. In order to avoid a like occurrence in the future, departmental supervision has taken steps toward effecting rigid compliance with the operating procedures.

## 2.3 X-Ray Equipment Survey

Procedure No. 15 of the Health Physics Manual (issued September 6, 1963) outlines requirements for the installation, regulation, and operation of X-ray producing equipment. The procedure provides that:

1. X-ray producing devices will be assigned a registry number by Health Physics and the registration number affixed permanently to the device.

2. Form TX-300 is prepared on which is recorded pertinent information regarding each X-ray producing device. A copy of Form TX-300, properly executed, is posted on each device or on the door of the enclosure which houses the device. Applied Health Physics headquarters retains a copy of the executed form on permanent file.

3. Each X-ray producing device is identified by yellow and magenta colored warning tape-signs labeled: CAUTION - THIS MACHINE PRODUCES X-RAYS WHEN ENERGIZED. The more hazardous X-ray producing installations are also labeled with large metal signs indicating the potential hazards involved.

Since the procedure was initiated, 69 X-ray producing units have been surveyed by Health Physics and registered. The survey resulted in several equipment and procedural modifications for improving the safety of operations. Division Radiation Control Officers have been provided with a list which shows the location of each unit and any suggested modifications.

# 3.0 DOSIMETRY SECTION

## 3.1 Summary of Personnel Monitoring

3.1.1 External Dosimetry - No employee exceeded a recommended maximum quarterly dose. The highest exposure, in terms of per cent of recommended maximum levels, was a total body dose of 1.8 rem which represents 60 per cent of the recommended maximum quarterly dose of 3 rem. Twelve individuals received a total body dose that equalled or exceeded 1/3 of the recommended maximum quarterly dose. The highest cumulative dose accrued this year through the third quarter was about 4.2 rem which represents 84 per cent of the recommended maximum yearly average dose of 5 rem. The highest total body skin dose received during the quarter was about 2.3 rem and represents 23 per cent of the recommended maximum quarterly limit. A breakdown of exposures is shown in Table 3.1.

### 3.1.2 Internal Dosimetry

Bio-Assays - Three employees continued to have estimated bone burdens of Pu-239 which approximate 1/3 of the recommended maximum body burden. No new cases involving a significant body burden developed during the third quarter.[1]

Whole Body Counter[2] - A total of 252 human counts on 233 persons was carried out by the staff of the whole body counting facility during the third quarter. Among the number counted, 46 individuals indicated measurable amounts of radioactivity above the average unexposed human background of about 20 nanocuries Cs-137. Table 3.2 gives a resume of analyses performed by whole body counting techniques.

## 3.2 Program Developments

3.2.1 Personnel Meters Reference Data - A cross-indexing system which utilizes IBM cards has been installed for use by the Health Physics Portals Group. The use of IBM cards is compatible with the various other dose data computer programs and permits internal audit control over all current personnel monitoring record data. Revision and replacement of parts or all of the indexing system may be done in less time and with less probability of error.

3.2.2 Personnel Identification Numbers - It is the practice at ORNL to issue personnel identification numbers to regular employees at the time of their employment for the purpose of minimizing record keeping errors where two or more persons have the same name. The personnel identification number assigned to regular employees is generally referred to as the

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[1] Action is taken to curtail an employee's exposure to internal emitters when measurements approach 30 per cent of a recommended maximum body burden.

[2] Data supplied by Health Physics Technology Section, B. R. Fish, Section Chief.

Table 3.1 Personnel Meters Exposure Resume—3rd Quarter, 1963

| Employee | Laboratory Division | Third Quarter Dose: Skin of Total Body (rem) | Third Quarter Dose: Total Body (rem) | Cumulative Dose for 1963: Skin of the Body (rem) | Cumulative Dose for 1963: Total Body (rem) |
|---|---|---|---|---|---|
| A | Isotopes | 2.3 | 1.8 | 5.3 | 4.2 |
| B | P and E | 1.8 | 1.8 | 2.1 | 2.0 |
| C | Isotopes | 2.0 | 1.6 | 4.9 | 4.0 |
| D | P and E | 1.4 | 1.4 | 1.6 | 1.5 |
| E | Thermonuclear | 1.3 | 1.3 | 4.1 | 4.0 |
| F | I and C | 1.5 | 1.2 | 3.9 | 3.4 |
| G | Thermonuclear | 1.3 | 1.2 | 3.2 | 3.1 |
| H | Health Physics | 1.6 | 1.1 | 2.0 | 1.5 |
| I | Isotopes | 1.4 | 1.1 | 3.9 | 3.1 |
| J | Isotopes | 1.3 | 1.0 | 4.1 | 3.4 |
| K | P and E | 1.3 | 1.0 | 2.3 | 1.7 |
| L | Thermonuclear | 1.0 | 1.0 | 1.5 | 1.4 |
| M | Isotopes | 1.2 | 0.9 | 4.0 | 3.3 |

Note: Table 3.1 includes a breakdown of exposures for employees whose recorded dose equals or exceeds approximately 1/3 (underlined value) of the recommended operating limits.

Table 3.2 Radioactivity Found in Laboratory Employees Investigated by Whole Body Counting Techniques During the Months of July, August, and September, 1963

| Isotope | No. of Persons* | Highest Quantity Measured (nc) |
|---|---|---|
| Cr-51 | 3 | 42 |
| Co-58 | 2 | 38 |
| Fe-59 | 3 | 15 |
| Co-60 | 3 | 16 |
| Cu-64 | 1 | trace |
| Zn-65 | 1 | trace |
| Se-75 | 2 | 250 |
| Zr-95, Nb-95 | 9 | 70 |
| Sb-125 | 3 | 10 |
| I-131 | 3 | 3.2 |
| Cs-137 | 33 | 120 |
| Ce-144, Pr-144 | 8 | 7 |

Note: None of the quantities measured was in excess of 0.5% of the maximum permissible body burden.

*More than one of the listed isotopes may have been seen in a single person's spectrum.

payroll number although it is not uncommon to hear it spoken of as the badge number. In the case of non-employees, it has not been the practice to assign a personnel identification number even though the individual is issued a permanent badge-meter when he is on a long-term assignment at the Laboratory.

The films which are placed in permanent badge-meters are processed routinely. Consequently, Health Physics has found it necessary to assign a personnel identification number to non-employees who possess a permanent badge-meter in order to provide for the X-ray identification of the monitoring films and to simplify dose analysis by computer techniques. The personnel identification number assigned to non-employees by Health Physics differs from the payroll number assigned to regular employees in that the non-employee identification number is preceded by a prefix consisting of a letter of the alphabet. The letter assigned depends upon the individual's work assignment at the Laboratory.

Prior to the third quarter, the non-employee personnel identification prefix number did not appear on the face of the badge-meter. However, during the third quarter, a method was devised for displaying the "prefix" number assigned to non-employees on the lower front portion of the badge-meter frame. The "payroll" number assigned to regular employees continues to appear under the employee's name as a part of the photographic insert.

3.2.3 <u>Personnel Monitoring of Visitors</u> - Effective August 5, 1963, only the films contained in the film meters assigned to visitors who enter Radiation Zones are to be scheduled for routine processing. All film meters assigned to visitors contain monitoring films. However, <u>films from film meters assigned to visitors who do not enter Radiation Zones are processed only in the event of an accidental exposure or for other special purposes</u>. The procedure (described in Official Bulletin AR-438 issued July 26, 1963) makes it the responsibility of the host Division to determine the need for its visitor to enter a Radiation Zone and requires that the Division representative who authorized the visit notify the Laboratory Protection Division accordingly. The tag-pass-meter, issued by the Laboratory Protection Division, is labeled "Metering Data Required" if the visitor is authorized to enter a Radiation Zone. If access to a Radiation Zone is not required, the tag-pass-meter is labeled "Entry to Radiation Zone Prohibited". Laboratory regulations provide that a visitor who carries a tag-pass-meter of this latter type may not enter a Radiation Zone; however, if an unexpected need arises for a visitor to enter a Radiation Zone, he may be permitted to enter after notifying the Laboratory Protection Division.

3.2.4 <u>Metering Program for Construction Personnel</u> - The issuance of badge-meters at ORNL to employees of the H. K. Ferguson Company, to supplement badge-meters issued by the Y-12 Plant, has been discontinued. Film meters used by Ferguson employees are processed by the Y-12 Plant and the H. K. Ferguson Company maintains its own personnel monitoring records which are available to ORNL. However, in order to expedite metering procedures, ORNL provides pocket meter service and reporting for all Ferguson employees assigned to perform work in the controlled areas at the X-10 site. Film meters are issued by ORNL to any construction worker who does not have an assigned meter when he arrives at the X-10 controlled area. (Construction workers not assigned to H. K. Ferguson Company are not normally provided film meters by the contractor-employer.) Badge-meters issued by ORNL to construction workers contain a laminated insert which shows the name of the individual to whom the meter is issued. Prior to this quarter the name was placed on the meter by use of "write-on tape". The practice of using a laminated insert has resulted in achieving greater accuracy in record keeping.

3.2.5 Reporting of Pocket Meter Data - A weekly report concerning pocket meter exposure data is derived by electro-data-processing techniques. The system uses daily readings as input information and produces a daily, weekly, and quarterly summary catalogued by departments for those employees who use pocket meters. The weekly report, derived also for H. K. Ferguson construction personnel, lists (1) the results for each employee for each day in which pocket meters were used, (2) the weekly total, and (3) the cumulative total for the calendar quarter. The weekly report is distributed to members of the Radiation Survey Section and to appropriate supervision.

3.2.6 Bio-Assay Sample Status Report - The status of the bio-assay sampling program is summarized in a weekly report prepared by electro-data processing techniques. The report shows the names of individuals, their work area, and the Division to which they are assigned. The status of the sampling program is defined as follows: (1) samples on request but not received, (2) samples received this week, (3) samples in process, and (4) samples, and results thereof, completed during the week. The report provides also, for supervisory use, a statistical summary of the status of all samples according to the type of analysis and sample priority.

3.2.7 Portable Instrument Data - A computer program for analyzing and reporting maintenance and calibration statistics for portable instruments has been adopted. The data will be summarized annually beginning with fiscal year 1963. The system provides for a running inventory to include (1) in-service data, (2) servicing costs, and (3) replacement needs. The number of assigned portable survey and monitoring instruments at the close of the third quarter was 1036.

3.2.8 Fast Neutron Survey Meter - The energy response (in terms of the NCRP rem dose) was determined for the ORNL Fast Neutron Survey Meter, Model Q-2047. Within the neutron energy range 0.15 to 5 MeV, the response of the instrument was found to be within 25 per cent of the NCRP values. The gamma radiation discrimination was excellent and no drift in the response during continuous use for eight hours was detected. (A complete report of the test is given in ORNL TM-653, Energy Response, Gamma Discrimination, and Stability of the ORNL Model 2047 Fast Neutron Survey Meter.)

3.2.9 Hand Exposure Meter - The ORNL Hand Exposure Meter was modified by the addition of a plastic filter for the purpose of providing a radiation response similar to that of the ORNL badge-meter.

3.2.10 New Cutie Pie - A prototype of a transistorized version of the ORNL Cutie Pie has been completed, tested, and evaluated by the AHP Instrumentation Group; it is now being field-tested by the Radiation Survey Section. The new design is expected to alleviate the problems of high resistance leakage experienced during the summer months; range switching has been simplified; and sensitivity to gamma radiation has been increased by a factor of about 4.

3.2.11 New Background Monitor - A dose integrating background monitor, designed to Health Physics specifications by the I and C Division, is being field-tested by the Environmental Monitoring Group. This instrument permits continuous, long term (30 days or more) accumulation of radiation background data and should result in the determination of a more reliable average background value than with techniques previously used.

3.2.12 Neutron Dosimeter - A neutron dosimeter (fabricated by the Texas Nuclear Corporation as Model 9120 and retailed for approximately $1600) has been tested and found to perform essentially as specified by the manufacturer. The instrument will provide for the monitoring and determination of intermediate energy neutrons.

# 4.0 ENVIRONMENTAL MONITORING

## 4.1 Summary of Atmospheric Monitoring

The average weekly concentrations of radioactive materials in air sampled by the three ORNL air monitoring networks are shown in Table 4.1. The quarterly average for the LAM[1] network was $5.0 \times 10^{-12}$ μc/cc with weekly values at individual monitoring stations ranging from a minimum of $1.2 \times 10^{-12}$ μc/cc to a maximum of $13 \times 10^{-12}$ μc/cc. Averages for the PAM[2] and RAM[3] networks were $3.1 \times 10^{-12}$ μc/cc and $3.6 \times 10^{-12}$ μc/cc respectively with weekly values ranging from a minimum of $1.0 \times 10^{-12}$ μc/cc to a maximum of $9.0 \times 10^{-12}$ μc/cc. The radioactive concentration in air continued a downward trend during the third quarter from the peak value reached during the month of April (second quarter) of this year (Fig. 4.1). The average values recorded by the LAM network were approximately 50 per cent higher than the average recorded by the PAM and RAM networks. The LAM network average value for this quarter was less than the average value reported for all stations (72) within the Radiation Surveillance Network of the U. S. Department of Health, Education and Welfare for the first six months of 1963.[4]

## 4.2 Fall-Out Measurements

Fall-out measurements as determined by the gummed paper technique[5] indicated that a downward trend began during the first part of the year and continued a steady decrease through the third quarter (Fig. 4.2). The number of radioactive particles per square foot collected as fall-out were about ten times more abundant during the previous quarter. The third quarter values are given, by weeks, for all networks in Table 4.2.

## 4.3 Water Analysis

Rain Water - The quarterly average concentration of radioactivity in rain water collected by the LAM network was $0.37 \times 10^{-7}$ μc/ml. The averages for the PAM and RAM networks were $0.45 \times 10^{-7}$ μc/ml and $0.48 \times 10^{-7}$ μc/ml respectively. The third quarter values are about 1/4 of the corresponding values measured during the previous quarter (Fig. 4.3). The third quarter values for individual stations are given in Table 4.3.

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[1] LAM - Local Air Monitor (located at or near the X-10 site).

[2] PAM - Perimeter Air Monitor (located on the outer boundary of the AEC controlled area).

[3] RAM - Remote Air Monitor (located from 12 to 75 miles from the X-10 site).

[4] "Radiological Health Data", U. S. Department of Health, Education, and Welfare, Public Health Service, Vol. IV, Numbers 5-10, 1963.

[5] The gummed paper collector presents a collection surface of 1 square foot. Radioparticulates per square foot are determined by autoradiography.

Table 4.1 Concentration of Radioactive Materials in Air Averaged Weekly from Filter Paper Data—3rd Quarter, 1963

| Week No | LAM Network[a] | PAM Network[b] | RAM Network[c] |
|---|---|---|---|
| 27 | $8.6 \times 10^{-12}$ μc/cc | $5.4 \times 10^{-12}$ μc/cc | $6.2 \times 10^{-12}$ μc/cc |
| 28 | 9.9 | 6.3 | 7.1 |
| 29 | 4.7 | 2.6 | 3.2 |
| 30 | 4.9 | 2.5 | 3.5 |
| 31 | 5.1 | 3.2 | 4.2 |
| 32 | 7.8 | 5.4 | 5.2 |
| 33 | 5.8 | 3.6 | 3.9 |
| 34 | 3.8 | 2.6 | 2.7 |
| 35 | 3.1 | 2.0 | 1.9 |
| 36 | 2.7 | 1.5 | 2.5 |
| 37 | 2.2 | 1.3 | 1.7 |
| 38 | 2.7 | 1.6 | 2.2 |
| 39 | 3.5 | 1.9 | 2.6 |
| Average for Quarter | $5.0 \times 10^{-12}$ μc/cc | $3.1 \times 10^{-12}$ μc/cc | $3.6 \times 10^{-12}$ μc/cc |
| Average for Year to Date | $6.0 \times 10^{-12}$ μc/cc | $5.0 \times 10^{-12}$ μc/cc | $5.4 \times 10^{-12}$ μc/cc |
| Average Last Year (1962) | $3.7 \times 10^{-12}$ μc/cc | $3.6 \times 10^{-12}$ μc/cc | $4.3 \times 10^{-12}$ μc/cc |

[a]LAM - Local Air Monitor (located at or near the X-10 site).

[b]PAM - Perimeter Air Monitor (located on the outer boundary of the AEC-controlled area).

[c]RAM - Remote Air Monitor (located from 12 to 75 miles from the X-10 site).

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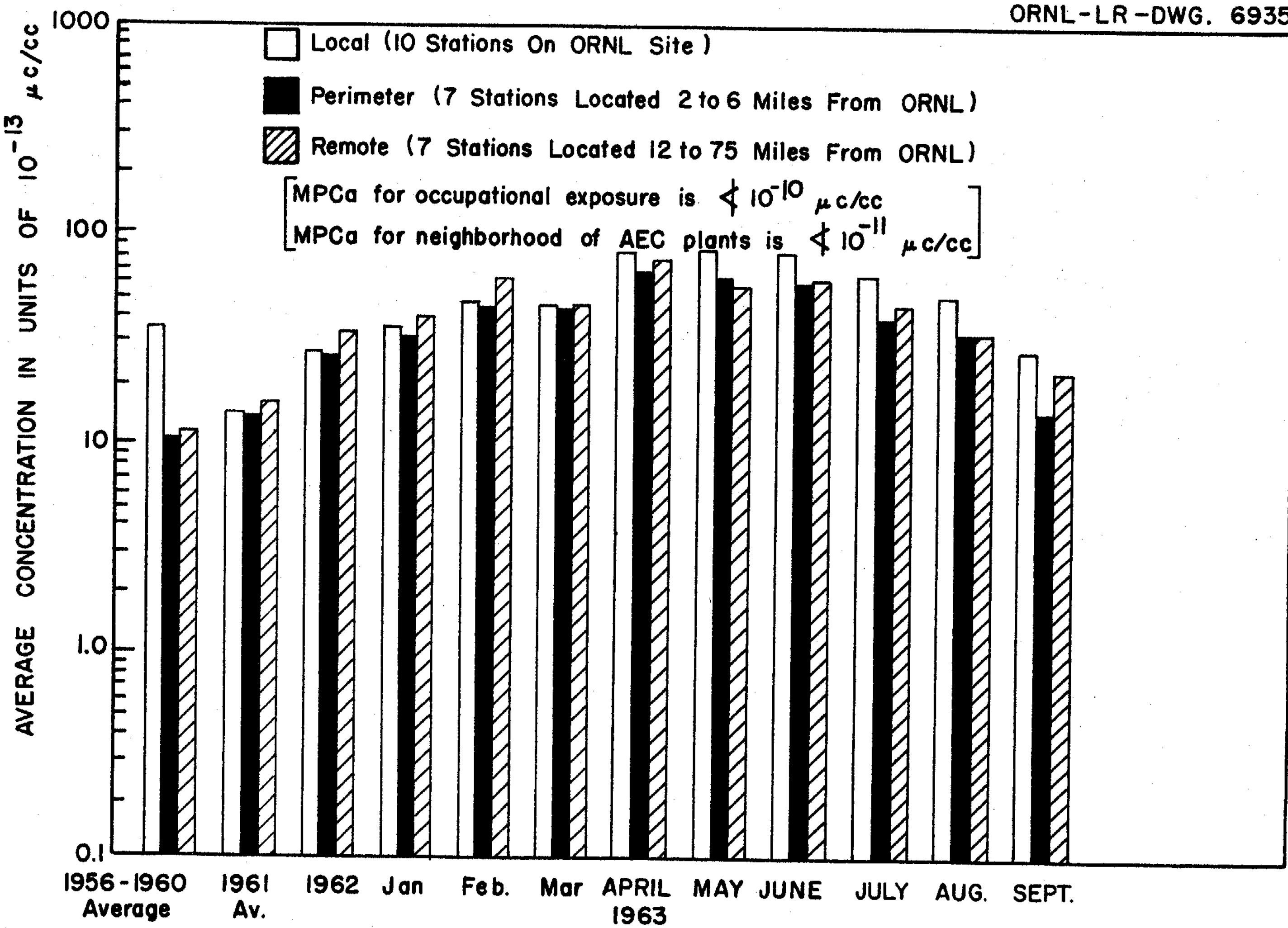


Fig. 4.1 Concentration Of Radioactive Materials in Air
(Filter Paper Data)

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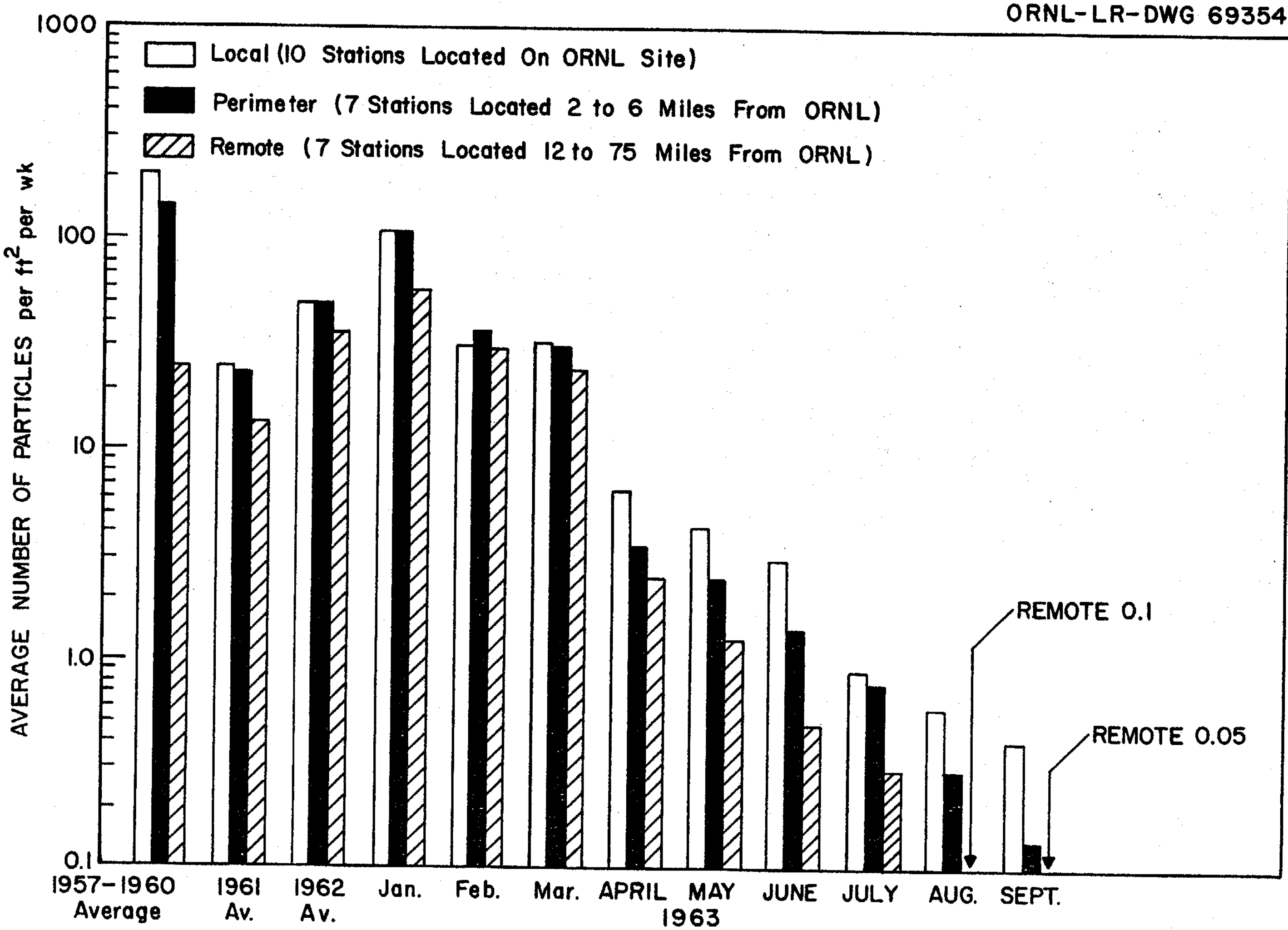


Fig. 4.2 Radioparticulate Fall-Out Measurements (Measured By Autoradiographic Techniques Using Gummed Paper Collectors)

Table 4.2 Radioparticulate Fall-Out Measurements Averaged Weekly From Gummed Paper Data—3rd Quarter, 1963

| Week No | LAM Network | PAM Network | RAM Network |
|---|---|---|---|
| 27 | 1.5 particles/ft$^2$/wk | 0.86 particles/ft$^2$/wk | 0.43 particles/ft$^2$/wk |
| 28 | 0.5 | 0.86 | 0.71 |
| 29 | 0.8 | 0.14 | 0.00 |
| 30 | 1.4 | 1.43 | 0.57 |
| 31 | 0.5 | 0.71 | 0.00 |
| 32 | 0.9 | 0.57 | 0.29 |
| 33 | 0.2 | 0.00 | 0.00 |
| 34 | 0.6 | 0.43 | 0.14 |
| 35 | 0.8 | 0.00 | 0.00 |
| 36 | 0.6 | 0.00 | 0.00 |
| 37 | 1.0 | 0.14 | 0.00 |
| 38 | 0.7 | 0.43 | 0.14 |
| 39 | 1.1 | 0.14 | 0.14 |
| Average for Quarter | 0.75 | 0.44 | 0.19 |

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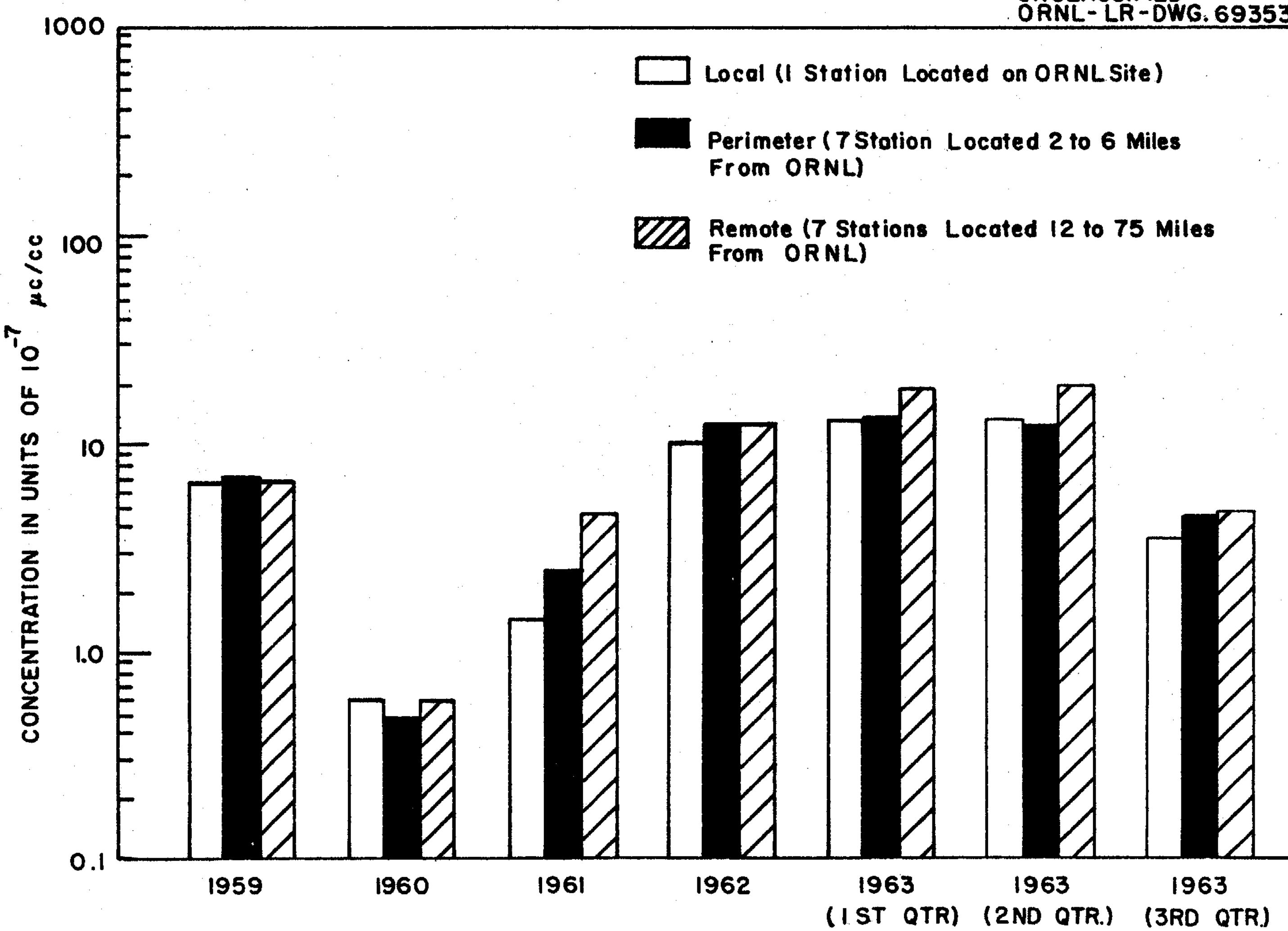


Fig 4.3 Concentration Of Radioactive Materials In Rain Water

Table 4.3 Concentration of Radioactive Materials in Rain Water Averaged for the Quarter by Stations—3rd Quarter, 1963

| Station Number | Location | Concentration |
|---|---|---|
| | **LAM Network** | |
| HP-7 | West of 7001 | $0.37 \times 10^{-6}$ μc/ml |
| | **PAM Network** | |
| HP-31 | Kerr Hollow Gate | $0.38 \times 10^{-6}$ μc/ml |
| HP-32 | Midway Gate | 0.34 |
| HP-33 | Gallaher Gate | 0.38 |
| HP-34 | White Oak Dam | 0.58 |
| HP-35 | Blair Gate | 0.45 |
| HP-36 | Turnpike Gate | 0.53 |
| HP-37 | Hickory Creek Bend | 0.48 |
| Network Average | | $0.45 \times 10^{-6}$ μc/ml |
| | **RAM Network** | |
| HP-51 | Norris Dam | $0.74 \times 10^{-6}$ μc/ml |
| HP-52 | Loudoun Dam | 0.41 |
| HP-53 | Douglas Dam | 0.39 |
| HP-54 | Cherokee Dam | 0.43 |
| HP-55 | Watts Bar Dam | 0.42 |
| HP-56 | Great Falls Dam | 0.64 |
| HP-57 | Dale Hollow | 0.36 |
| Network Average | | $0.48 \times 10^{-6}$ μc/ml |

1Q 290
2Q 74
3Q 63
427 + 4Q?

Clinch River Water - Approximately 63 curies of radioactive materials were discharged via White Oak Creek into the Clinch River during the third quarter of 1963 as compared to 74 curies released to the river during the second quarter of this year. The isotopic distribution of the White Oak Lake effluent is given for the months of July, August, and September in Table 4.4. About 78 per cent of the radioactivity contained in the White Oak Lake effluent was attributed to Ru-106 which entered White Oak Creek from the seepage pit disposal system.[6] However, Ru-106 contributed only about 14 per cent to the applicable maximum permissible concentration for drinking water, $(MPC)_w$, which is a calculated value derived for the mixture of radionuclides known to be carried by White Oak Lake effluent as it passes into Clinch River water at Clinch River Mile (CRM) 20.8. Assuming uniform mixing of White Oak Lake effluent with Clinch River water at the confluence of the two streams (CRM 20.8), the calculated monthly average gross beta concentration in the Clinch River resulting from ORNL liquid waste discharges was as follows:

| Month | Concentration[7] | % $(MPC)_w$[8] |
|---|---|---|
| July | $0.26 \times 10^{-6}$ μc/ml | 9.8 |
| August | $0.04 \times 10^{-6}$ μc/ml | 2.1 |
| September | $0.01 \times 10^{-6}$ μc/ml | 0.95 |
| | Average | 4.3 |

The higher concentration value shown for the month of July reflects the greater amount of radioactivity discharged to the Clinch River during this month. A total of 50 curies of radioactivity was discharged from White Oak Lake during the month of July. The values for the months of August and September were 9 curies and 4 curies respectively.

The average concentration value for the second quarter of 1963 was 5.8 per cent of the $(MPC)_w$.

The average concentration of the major radioactive constituents in Clinch River water at CRM 20.8 is given in Table 4.5.

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[6]Monthly reports, "Laboratory Facilities - Waste Disposal", L. C. Lasher.

[7]Calculated values based upon the dilution afforded by the river; these values do not include radioactive materials (e.g., fall-out) that enter the river upstream from CRM 20.8.

[8]Weighted average $(MPC)_w$ for persons residing in the neighborhood of a controlled area calculated for the isotopic mixture using $(MPC)_w$ values for specific radionuclides recommended in NBS Handbook 69.

Table 4.4 Radioisotopic Distribution in White Oak Lake Effluent—3rd Quarter, 1963

| Isotope | % of Total Beta Radioactivity | | |
|---|---|---|---|
| | July | August | September |
| $Ru^{106}$ | 87 | 72 | 62 |
| $Zr^{95}$ | 0.04 | 0.36 | 0.14 |
| $Nb^{95}$ | 0.09 | 0.8 | 0.0 |
| TRE (less $Ce^{144}$)* | 2.7 | 9.9 | 13 |
| $Cs^{137}$ | 1.0 | 2.6 | 5.9 |
| $I^{131}$ | 0.04 | 0.2 | 0.43 |
| $Ce^{144}$ | 0.09 | 0.6 | 1.3 |
| $Ba^{140}$ | 0.13 | 0.2 | 0.43 |
| $Co^{60}$ | 5.3 | 8.1 | 6.2 |
| $Sr^{89}$ | 0.38 | 0.5 | 1.0 |
| $Sr^{90}$ | 3.2 | 4.8 | 9.0 |

*TRE-Total rare earths

Table 4.5 Average Concentration of Major Radioactive Constituents in the Clinch River at Mile 20.8 Resulting from ORNL Waste Releases via White Oak Lake[a]—3rd Quarter, 1963

| Month | Radionuclides of Primary Concern ($10^{-8}$ μc/ml) | | | | | Gross Beta | $(MPC)_w$[b] | % |
|---|---|---|---|---|---|---|---|---|
| | $Sr^{90}$ | $Ce^{144}$ | $Cs^{137}$ | $Ru^{103-106}$ | $Co^{60}$ | ($10^{-6}$ μc/ml) | ($10^{-6}$ μc/ml) | $(MPC)_w$[b] |
| July | 0.24 | 0.006 | 0.07 | 6.3 | 0.39 | 0.26 | 2.6 | 9.8 |
| August | 0.18 | 0.024 | 0.10 | 2.7 | 0.30 | 0.04 | 2.1 | 2.1 |
| September | 0.08 | 0.011 | 0.05 | 0.52 | 0.05 | 0.01 | 1.3 | 0.95 |

[a]Calculated values based upon the dilution afforded by the river; these values do not include radioactive materials (e.g., fall-out) that enter the river upstream from CRM 20.8.

[b]Weighted average $(MPC)_w$ for populations residing in the neighborhood of a controlled area calculated for the mixture using $(MPC)_w$ values for specific radionuclides recommended in NBS Handbook 69.

The measured average concentrations of radioactive materials in Clinch River water sampled at the ORGDP filtration plant intake (CRM 14.5) were as follows:

| Month | Concentration | % $(MPC)_w$ |
|---|---|---|
| July | $0.14 \times 10^{-6}$ μc/ml | 5.6 |
| August | $0.07 \times 10^{-6}$ μc/ml | 5.4 |
| September | $0.02 \times 10^{-6}$ μc/ml | 2.2 |
| | Average | 4.4 |

A comparison of the per cent $(MPC)_w$, by months, for the first nine months of 1963 with values determined for the years 1956 through 1962 is presented in Fig. 4.4.

The concentration of Sr-90 and Ru-106 in Clinch River water at the ORGDP water filtration plant intake (CRM 14.5) is given in Table 4.6.

## 4.4 Background Measurements of Ionizing Radiation

The average background level recorded during the third quarter at the 53 stations located on or near the X-10 site was 0.11 mR/hr. The background levels measured at individual stations ranged from a minimum of 0.014 mR/hr to a maximum of 1.8 mR/hr. The average level recorded at five stations located off-site around the perimeter of the AEC controlled area was 0.033 mR/hr. The average levels for the quarter, both on-site and off-site, were essentially the same as were recorded last quarter. The third quarter background levels recorded at the X-10 site were about ten times those recorded in 1943 (table 4.7) prior to the start-up of the graphite reactor; the background averages on the perimeter of the AEC controlled area were about two and one-half times the 1943 level. The average background for the first three quarters of 1963 and for the years 1959 through 1962 is presented in Fig. 4.5. The cumulative radiation dose at the outer fence which encloses the Tower Shielding Facility was essentially zero.[9]

## 4.5 Raw Milk Analysis

Radioiodine concentration values derived for 67 per cent of the raw milk samples analyzed during the third quarter were below the minimum detectable limit of 10 pc/l. The maximum value measured for an individual sample was 68 pc/l. Assuming 5 pc/l (1/2 the minimum detectable limit) to be the value for each sample below the minimum detectable limit, the average radioiodine concentration for all samples analyzed during the quarter was 10 pc/l. The third quarter average did not differ from the second quarter average and was about 20 per cent of the average concentration recorded during the first quarter of 1963. The yearly average during 1962 was about ten times the third quarter average.

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[9] Report from L. B. Holland to file, dated October 1, 1963.

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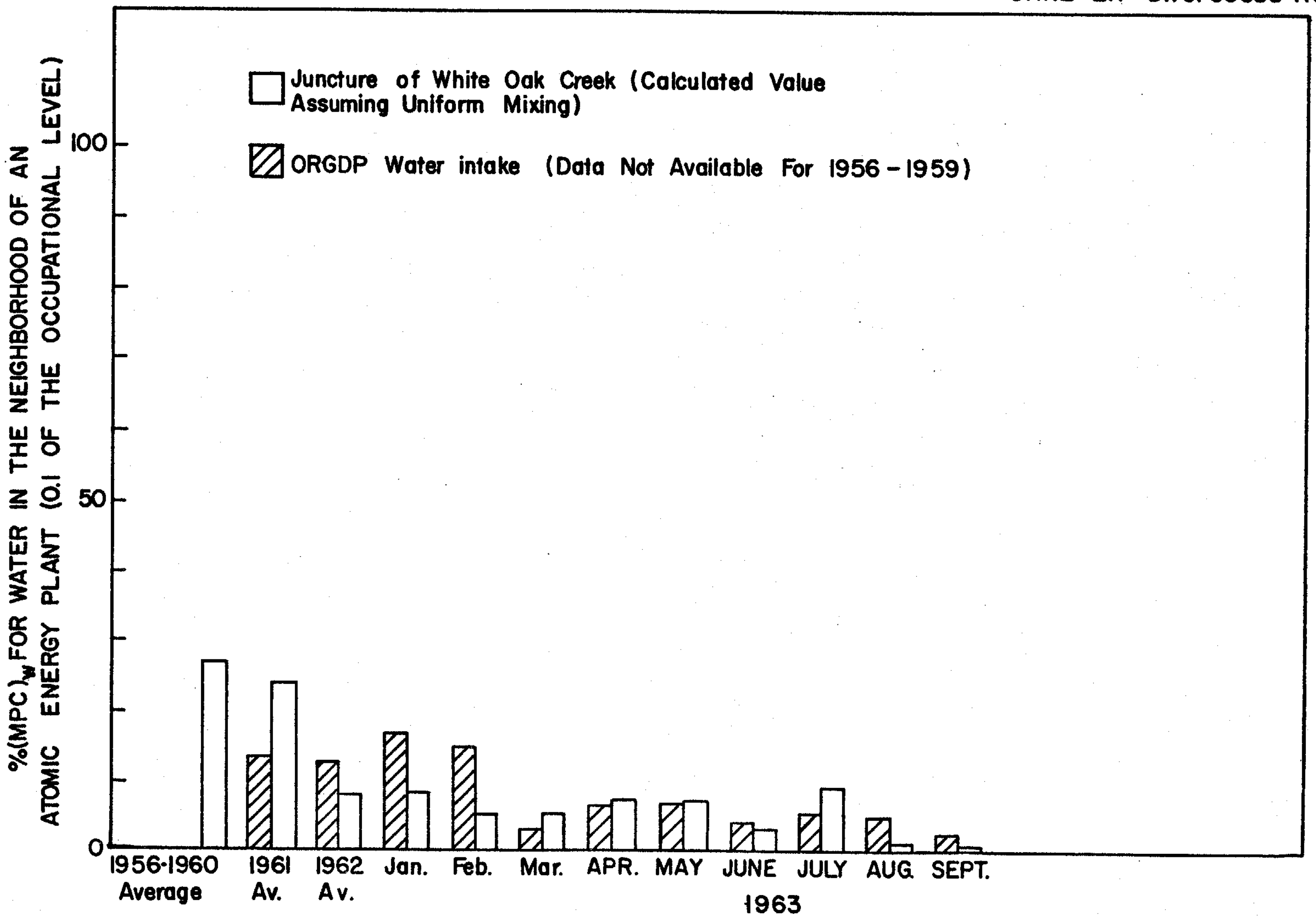


Fig.4.4 Radioactive Content Of Clinch River Water

Table 4.6 Average Concentration[a] of Radioactive Materials in Clinch River Water at ORGDP Filtration Plant Intake—3rd Quarter, 1963

| Month | Radionuclides of Primary Concern ($10^{-8}$ μc/ml) | | Gross Beta | $(MPC)_w$[b] | % |
|---|---|---|---|---|---|
| | $Sr^{90}$ | $Ru^{103-106}$ | ($10^{-6}$ μc/ml) | ($10^{-6}$ μc/ml) | $(MPC)_w$[b] |
| July | 0.50 | 10 | 0.14 | 2.5 | 5.6 |
| August | 0.54 | 5 | 0.07 | 1.3 | 5.4 |
| September | 0.36 | 1 | 0.02 | 0.92 | 2.2 |

[a]Observed values based on analyses of monthly composited samples.

[b]Weighted average $(MPC)_w$ for populations in the vicinity of a controlled area calculated for the mixture using $(MPC)_w$ values for specific radionuclides recommended in NBS Handbook 69.

Table 4.7 Background Measurements of Ionizing Radiation—3rd Quarter, 1963

| Area | Monthly Average for All Stations (mR/hr) | | | Quarterly Average for All Stations (mR/hr) | Year to Date Average All Stations (mR/hr) |
|---|---|---|---|---|---|
| | July | August | September | | |
| Laboratory Site (53 stations) | 0.13 | 0.10 | 0.11 | 0.11 | 0.11 |
| Off-Site (Oak Ridge Controlled Area) (5 stations) | 0.032 | 0.032 | 0.035 | 0.033 | 0.030 |

Note: The background in the Oak Ridge area in 1943 was determined to be approximately 0.012 mR/hr.

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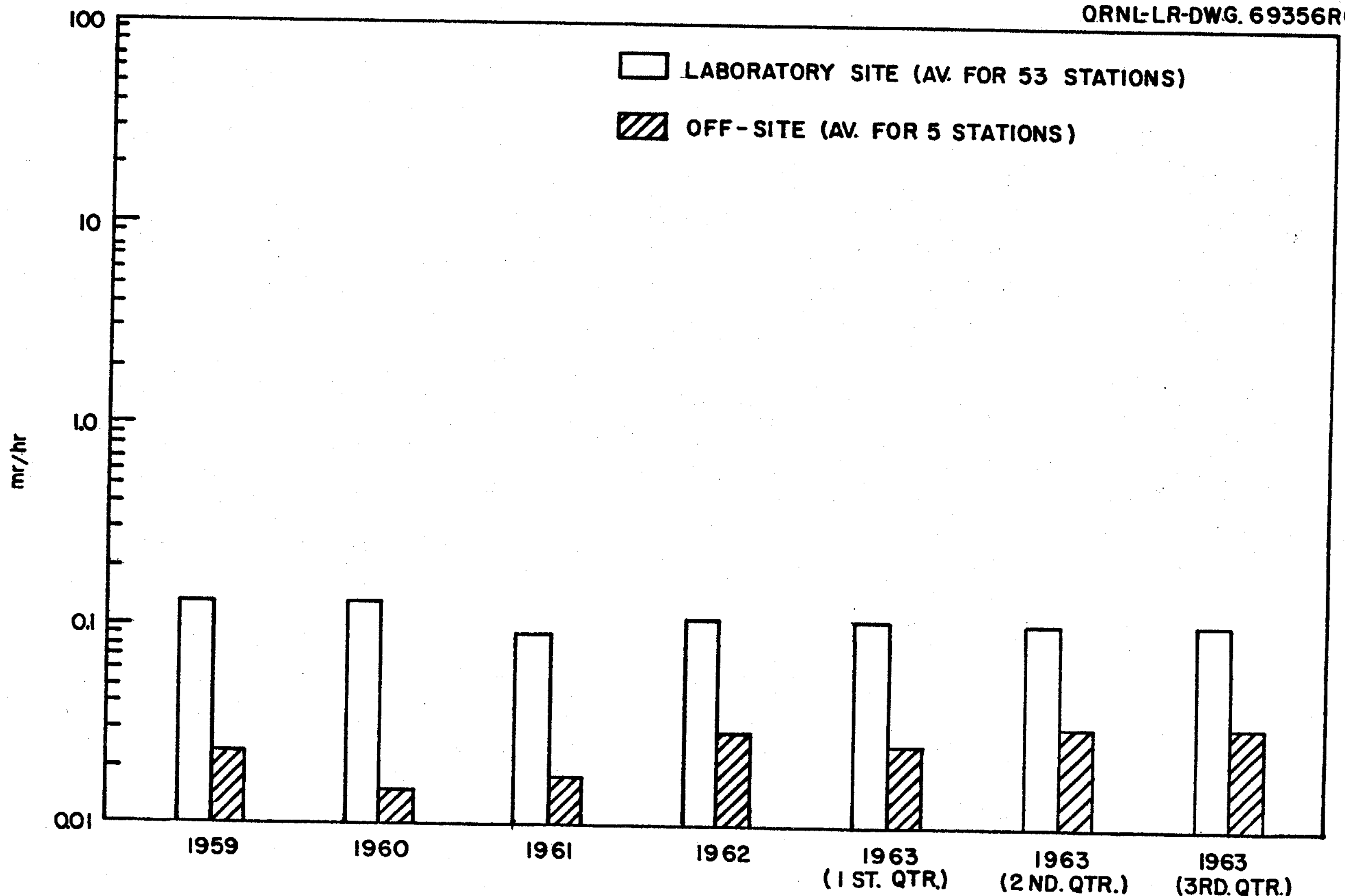


Fig 4.5 Background Measurements Of Ionizing Radiation

The average concentration of Sr-90 in raw milk samples was 47 pc/l. The values for individual samples ranged from a minimum of 10 pc/l to a maximum of 150 pc/l. Assuming a daily intake of 1 liter of milk per day, the average concentration of Sr-90 in milk for the third quarter of 1963 was about 25 per cent of the upper limit of FRC Range II for the daily intake of Sr-90.

4.6 Cattle Thyroid Analysis

Experiments have shown that cattle thyroid analysis provides a practical method for the detection of radioiodine in the environment. Although this particular technique does not present a means of evaluating the hazard to man from I-131 located in the environment, it does provide a much more sensitive indicator for detecting the presence of radioiodine in the environment than is available by milk analysis.[10] Near the close of the third quarter arrangements were made to obtain a suitable number of cattle thyroids each week through a cooperative program with the UT-AEC research staff. The thyroids provided are taken from cattle pastured within a 100-mile radius of Oak Ridge and radioiodine analysis is accomplished by gamma scintillation counting techniques using a 4" x 5" crystal and a single channel gamma spectrometer.

[10] ORNL-3492, Applied Health Physics Annual Report for 1962, p. 72.

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